

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

## Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*University of Dortmund, Germany*

Madhu Sudan

*Massachusetts Institute of Technology, MA, USA*

Demetri Terzopoulos

*New York University, NY, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Moshe Y. Vardi

*Rice University, Houston, TX, USA*

Gerhard Weikum

*Max-Planck Institute of Computer Science, Saarbruecken, Germany*

Jürgen Giesl (Ed.)

# Term Rewriting and Applications

16th International Conference, RTA 2005  
Nara, Japan, April 19-21, 2005  
Proceedings

Volume Editor

Jürgen Giesl  
RWTH Aachen  
Lehr- und Forschungsgebiet für Informatik II  
Ahornstr. 55, 52074 Aachen, Germany  
E-mail: giesl@informatik.rwth-aachen.de

Library of Congress Control Number: 2005923620

CR Subject Classification (1998): F.4, F.3.2, D.3, I.2.2-3, I.1

ISSN	0302-9743
ISBN-10	3-540-25596-6 Springer Berlin Heidelberg New York
ISBN-13	978-3-540-25596-3 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

[springeronline.com](http://springeronline.com)

© Springer-Verlag Berlin Heidelberg 2005  
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Olgun Computergrafik  
Printed on acid-free paper      SPIN: 11416999      06/3142      5 4 3 2 1 0

# Preface

This volume contains the proceedings of the *16th International Conference on Rewriting Techniques and Applications* (RTA 2005), which was held on April 19–21, 2005, at the Nara-Ken New Public Hall in the center of the Nara National Park in Nara, Japan.

RTA is the major forum for the presentation of research on all aspects of rewriting. Previous RTA conferences were held in Dijon (1985), Bordeaux (1987), Chapel Hill (1989), Como (1991), Montreal (1993), Kaiserslautern (1995), Rutgers (1996), Sitges (1997), Tsukuba (1998), Trento (1999), Norwich (2000), Utrecht (2001), Copenhagen (2002), Valencia (2003), and Aachen (2004).

This year, there were 79 submissions from 20 countries, of which 31 papers were accepted for publication (29 regular papers and 2 system descriptions). The submissions came from France (10 accepted papers of the 23.1 submitted papers), USA (5.6 of 11.7), Japan (4 of 9), Spain (2.7 of 6.5), UK (2.7 of 4.7), The Netherlands (1.7 of 3.8), Germany (1.3 of 2.3), Austria (1 of 1), Poland (1 of 1), Israel (0.5 of 0.8), Denmark (0.5 of 0.5), China (0 of 4), Korea (0 of 4), Taiwan (0 of 1.3), Australia (0 of 1), Brazil (0 of 1), Russia (0 of 1), Switzerland (0 of 1), Sweden (0 of 1), and Italy (0 of 0.3).

Each submission was assigned to at least three Program Committee members, who carefully reviewed the papers, with the help of 111 external referees. Afterwards, the submissions were discussed by the Program Committee during one week through the Internet by means of Andrei Voronkov's *EasyChair* system. I want to thank Andrei very much for providing his system which was very helpful for the management of the submissions and reviews and for the discussion of the Program Committee.

The Program Committee decided to award a prize of 100,000 Yen for the best paper to the article *Extending the Explicit Substitution Paradigm* by Delia Kesner and Stéphane Lengrand. Moreover, student travel grants were awarded to Jérôme Rocheteau (author of the paper  *$\lambda\mu$ -Calculus and Duality: Call-by-Name and Call-by-Value*) and Wojciech Moczydłowski (co-author of the paper *Termination of Single-Threaded One-Rule Semi-Thue Systems*).

RTA 2005 had three invited talks, by Yoshihito Toyama (*Confluent Term Rewriting Systems*), Philip Wadler (*Call-by-Value is Dual to Call-by-Name – Reloaded*), and Amy Felty (*A Tutorial Example of the Semantic Approach to Foundational Proof-Carrying Code*). The talk by Amy Felty was a joint invited talk of RTA and the collocating *7th International Conference on Typed Lambda Calculi and Applications* (TLCA 2005).

Since RTA 2005 marked the 20th anniversary of RTA, this anniversary was celebrated with a special session of invited talks on the history and future of RTA and rewriting. For this session, we invited Gérard Huet (*Before RTA: Early Days in Rewriting Research*), Jean-Pierre Jouannaud (*Twenty Years Later*), and Nachum Dershowitz (*Open. Closed. Open.*). I want to thank both the invited

speakers of RTA and of the anniversary session for their interesting and inspiring talks.

RTA 2005 was held as part of the *Federated Conference on Rewriting, Deduction, and Programming* (RDP), together with the following events. I wish to thank the organizers of these events for making the conference even more attractive:

- *7th International Conference on Typed Lambda Calculi and Applications*, TLCA 2005 (Program Chair: Paweł Urzyczyn, Conference Chair: Masahito Hasegawa)
- *6th International Workshop on Rule-Based Programming*, RULE 2005 (Horatiu Cirstea, Narciso Martí-Oliet)
- *19th International Workshop on Unification*, UNIF 2005 (Laurent Vigneron)
- *5th International Workshop on Reduction Strategies in Rewriting and Programming*, WRS 2005 (Roberto Di Cosmo, Yoshihito Toyama)
- IFIP Working Group 1.6 on Term Rewriting (Claude Kirchner)

Many people helped to make RTA 2005 a success. In particular, I want to thank Hitoshi Ohsaki, the conference chair of RTA 2005, and the other members of the Organizing Committee, who organized the conference in a very careful and completely perfect way. I am also very grateful to the members of the Program Committee, to the external reviewers, to the former and current publicity chairs of RTA (Femke van Raamsdonk and Ralf Treinen), to the sponsors of the conference, and to René Thiemann and Peter Schneider-Kamp for helping with many technical problems.

February 2005

Jürgen Giesl

# Conference Organization

## Program Chair

Jürgen Giesl *RWTH Aachen*

## Conference Chair

Hitoshi Ohsaki *AIST*

## Program Committee

Franz Baader	<i>Dresden</i>
Mariangiola Dezani	<i>Torino</i>
Jürgen Giesl	<i>Aachen</i>
Bernhard Gramlich	<i>Vienna</i>
Florent Jacquemard	<i>Cachan</i>
Claude Kirchner	<i>Nancy</i>
Pierre Lescanne	<i>Lyon</i>
Aart Middeldorp	<i>Innsbruck</i>
Hitoshi Ohsaki	<i>Amagasaki</i>
Vincent van Oostrom	<i>Utrecht</i>
Christine Paulin-Mohring	<i>Orsay</i>
Frank Pfenning	<i>Pittsburgh</i>
Femke van Raamsdonk	<i>Amsterdam</i>
Mark-Oliver Stehr	<i>Urbana</i>
Rakesh Verma	<i>Houston</i>
Andrei Voronkov	<i>Manchester</i>

## Organizing Committee

Kokichi Futatsugi	<i>Tatsunokuchi</i>	
Masami Hagiya	<i>Tokyo</i>	
Teruo Higashino	<i>Osaka</i>	
Maki Ishida	<i>Amagasaki</i>	(Secretary)
Hitoshi Ohsaki	<i>Amagasaki</i>	
Toshiki Sakabe	<i>Nagoya</i>	
Hiroyuki Seki	<i>Nara</i>	
Yoshihito Toyama	<i>Tohoku</i>	

## RTA Steering Committee

Jürgen Giesl	<i>Aachen</i>	
Delia Kesner	<i>Paris</i>	
Robert Nieuwenhuis	<i>Barcelona</i>	
Ralf Treinen	<i>Cachan</i>	(Publicity Chair)
Vincent van Oostrom	<i>Utrecht</i>	
Femke van Raamsdonk	<i>Amsterdam</i>	(Chair)

## Sponsors

Foundation for Nara Institute of Science and Technology  
 Information Processing Society of Japan (IPSJ)  
 Japan Society for the Promotion of Science (JSPS)  
 Kayamori Foundation of Informational Science Advancement  
 Nara Convention Bureau (NCB)  
 The Institute of Electronics, Information and Communication Engineers (IEICE)  
 The Telecommunications Advancement Foundation (TAF)

## Referees

Takahito Aoto	Germain Faure	Florent Kirchner
Philippe Audebaud	Jean-Christophe Filliatre	Francis Klay
Jürgen Avenhaus	Thomas Forster	Konstantin Korovin
Steffen van Bakel	Laurent Fribourg	Keiichirou Kusakari
Franco Barbanera	Gerhard Friedrich	Ralf Küsters
Clara Bertolissi	Fabio Gadducci	Jordi Levy
Stefan Blom	Florent Garnier	Zhiyao Liang
Viviana Bono	Alfons Geser	Ugo de Liguoro
Olivier Bournez	Herman Geuvers	Sébastien Limet
Roberto Bruni	Silvio Ghilardi	Salvador Lucas
Pierre Castéran	Robert Glück	Denis Lugiez
Kaustuv Chaudhuri	Isabelle Gnaedig	Bas Luttik
Horatiu Cirstea	Jean Goubault-Larrecq	Chris Lynch
Evelyne Contejean	Makoto Hamana	Sebastian Maneth
Veronique Cortier	Michael Hanus	Mircea Marin
Ferruccio Damiani	Joe Hendrix	Ursula Martin
Rowan Davies	Fritz Henglein	Jean-François Monin
Giorgio Delzanno	Hugo Herbelin	Pierre-Etienne Moreau
Catherine Dubois	Nao Hirokawa	Georg Moser
Rachid Echahed	Yuichi Kaji	Fabrice Nahon
Santiago Escobar	Delia Kesner	Aleks Nanevski
Moreno Falaschi	Jeroen Ketema	Paliath Narendran
Azadeh Farzan	Assaf Kfoury	Naoki Nishida

Albert Oliveras	Claudio Sacerdoti	Cesare Tinelli
Peter Ölveczky	Masahiko Sakai	Sophie Tison
Vincent Padovani	Sylvain Salvati	Ashish Tiwari
Miguel Palomino	Gernot Salzer	Yoshihito Toyama
Luca Paolini	Anderson Santana	Ralf Treinen
David Plaisted	Manfred Schmidt-Schauß	Xavier Urbain
Jeff Polakow	Peter Schneider-Kamp	Kumar Neeraj Verma
Emmanuel Polonovski	Takahiro Seino	Fer-Jan de Vries
Silvio Ranise	Hiroyuki Seki	Christoph Walther
Christophe Ringeissen	Vitaly Shmatikov	Geoffrey Washburn
Simona R. Della Rocca	Jakob Grue Simonsen	Herbert Wiklicky
Michael Rusinowitch	Toshinori Takai	Toshiyuki Yamada
Claudio Russo	Prasanna Thati	Hans Zantema
Tatiana Rybina	René Thiemann	Pascal Zimmer



# Table of Contents

Confluent Term Rewriting Systems .....	1
<i>Yoshihito Toyama</i>	
Generalized Innermost Rewriting .....	2
<i>Jaco van de Pol and Hans Zanen</i>	
Orderings for Innermost Termination .....	17
<i>Mirtha-Lina Fernández, Guillem Godoy, and Albert Rubio</i>	
Leanest Quasi-orderings .....	32
<i>Nachum Dershowitz and E. Castedo Ellerman</i>	
Abstract Modularity .....	46
<i>Michael Abbott, Neil Ghani, and Christoph Lüth</i>	
Union of Equational Theories: An Algebraic Approach .....	61
<i>Piotr Hoffman</i>	
Equivariant Unification .....	74
<i>James Cheney</i>	
Faster <i>Basic Syntactic Mutation</i> with Sorts for Some Separable Equational Theories .....	90
<i>Christopher Lynch and Barbara Morawska</i>	
Unification in a Class of Permutative Theories .....	105
<i>Thierry Boy de la Tour and Mnacho Echenim</i>	
Dependency Pairs for Simply Typed Term Rewriting .....	120
<i>Takahito Aoto and Toshiyuki Yamada</i>	
Universal Algebra for Termination of Higher-Order Rewriting .....	135
<i>Makoto Hamana</i>	
Quasi-interpretations and Small Space Bounds .....	150
<i>Guillaume Bonfante, Jean-Yves Marion, and Jean-Yves Moyen</i>	
A Sufficient Completeness Reasoning Tool for Partial Specifications .....	165
<i>Joe Hendrix, Manuel Clavel, and José Meseguer</i>	
Tyrolese Termination Tool .....	175
<i>Nao Hirokawa and Aart Middeldorp</i>	
Call-by-Value Is Dual to Call-by-Name – Reloaded .....	185
<i>Philip Wadler</i>	

$\lambda\mu$ -Calculus and Duality: Call-by-Name and Call-by-Value .....	204
<i>Jérôme Rocheteau</i>	
Reduction in a Linear Lambda-Calculus with Applications to Operational Semantics .....	219
<i>Alex Simpson</i>	
Higher-Order Matching in the Linear Lambda Calculus in the Absence of Constants Is NP-Complete .....	235
<i>Ryo Yoshinaka</i>	
Localized Fairness: A Rewriting Semantics .....	250
<i>José Meseguer</i>	
Partial Inversion of Constructor Term Rewriting Systems .....	264
<i>Naoki Nishida, Masahiko Sakai, and Toshiki Sakabe</i>	
Natural Narrowing for General Term Rewriting Systems .....	279
<i>Santiago Escobar, José Meseguer, and Prasanna Thati</i>	
The Finite Variant Property: How to Get Rid of Some Algebraic Properties .....	294
<i>Hubert Comon-Lundh and Stéphanie Delaune</i>	
Intruder Deduction for AC-Like Equational Theories with Homomorphisms .....	308
<i>Pascal Lafourcade, Denis Lugiez, and Ralf Treinen</i>	
Proving Positive Almost-Sure Termination .....	323
<i>Olivier Bournez and Florent Garnier</i>	
Termination of Single-Threaded One-Rule Semi-Thue Systems .....	338
<i>Wojciech Moczyłowski and Alfons Geser</i>	
On Tree Automata that Certify Termination of Left-Linear Term Rewriting Systems .....	353
<i>Alfons Geser, Dieter Hofbauer, Johannes Waldmann, and Hans Zantema</i>	
Twenty Years Later .....	368
<i>Jean-Pierre Jouannaud</i>	
Open. Closed. Open. ....	376
<i>Nachum Dershowitz</i>	
A Tutorial Example of the Semantic Approach to Foundational Proof-Carrying Code.....	394
<i>Amy P. Felty</i>	

Extending the Explicit Substitution Paradigm .....	407
<i>Delia Kesner and Stéphane Lengrand</i>	
Arithmetic as a Theory Modulo .....	423
<i>Gilles Dowek and Benjamin Werner</i>	
Infinitary Combinatory Reduction Systems .....	438
<i>Jeroen Ketema and Jakob Grue Simonsen</i>	
Proof-Producing Congruence Closure .....	453
<i>Robert Nieuwenhuis and Albert Oliveras</i>	
The Algebra of Equality Proofs .....	469
<i>Aaron Stump and Li-Yang Tan</i>	
On Computing Reachability Sets of Process Rewrite Systems .....	484
<i>Ahmed Bouajjani and Tayssir Touili</i>	
Automata and Logics for Unranked and Unordered Trees .....	500
<i>Iovka Boneva and Jean-Marc Talbot</i>	
<b>Author Index</b> .....	517